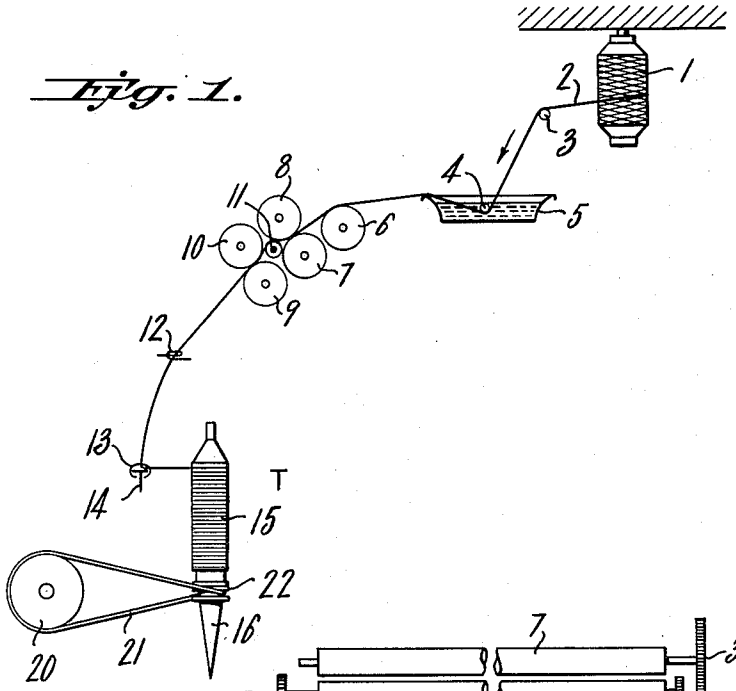
Aug. 3, 1937. B. H. FOSTER 2,089,021

ASBESTOS YARN

Filed Sept. 22, 1936 2 Sheets-Sheet 1

Fig. 1.



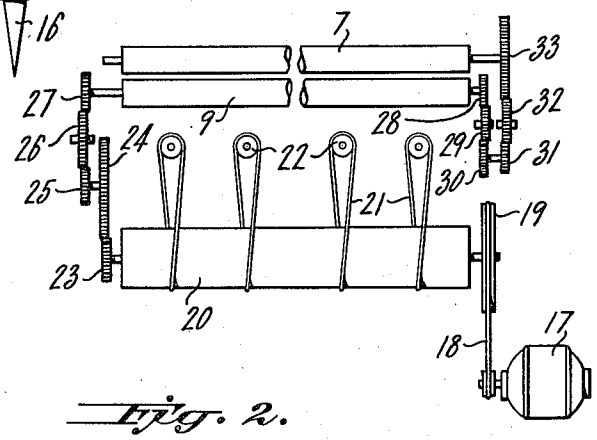


Fig. 2.

INVENTOR
BOUTWELL H. FOSTER
BY Walter L. Fister
ATTORNEY

Aug. 3, 1937. B. H. FOSTER 2,089,021

ASBESTOS YARN

Filed Sept. 22, 1936 2 Sheets-Sheet 2

Fig. 3.

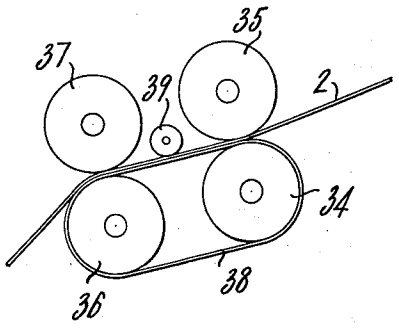
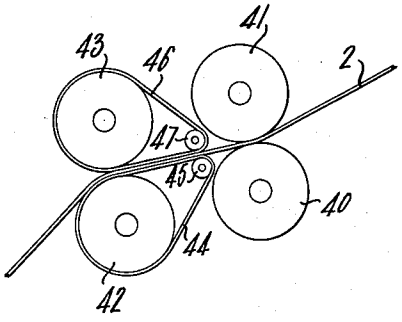


Fig. 4.



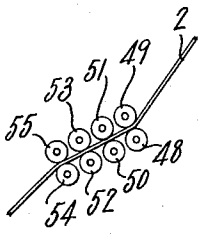


Fig. 5.

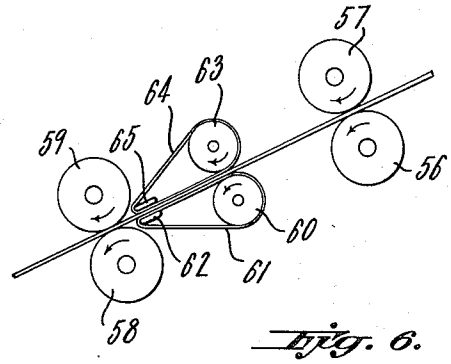


Fig. 6.

INVENTOR
BOUTWELL H. FOSTER
BY
Walter N. Tupes
ATTORNEY

Patented Aug. 3, 1937 2,089,021

UNITED STATES PATENT OFFICE

2,089,021

ASBESTOS YARN

Boutwell H. Foster, Maplewood, N. J., assignor to United States Rubber Products, Inc., New York, N. Y., a corporation of Delaware

Application September 22, 1936, Serial No. 101,922

18 Claims. (Cl. 117—52)

This invention relates to new and improved asbestos yarns, and more particularly to a drafted asbestos yarn.

The present application is a continuation-in-part of my copending application Serial No. 2,221, filed January 17, 1935.

Asbestos yarn is widely used in the arts in the making of fabrics for fire curtains and other fire proofing purposes, clutch facings, tapes, brake lining, and many other applications. In the method previously used for making commercial yarn, the relatively short asbestos fiber after passing through the usual preparatory operations, such as crushing, opening and cleaning, is mixed or blended with a small proportion of a vegetable fiber, usually cotton, and then carded. The percentage of cotton may be varied to some extent, but it is usually employed in the amount of about 15%. With a less cotton content than this, with the relatively short asbestos fiber stock in use, considerable difficulty has been had in the carding and spinning operations. However, recent improvements in carding and other operations have enabled spinnable rovings to be made containing as low as 8% cotton. In passing through the carding operation, the carded web is split into narrow strips which are thereafter compacted by rolling them between rub aprons to form rovings. The rovings are then passed through a pair of delivery rollers to a mule or ring spinning frame and spun without drafting. Accordingly, it has been necessary to prepare a different size of roving for the production of each different size of yarn. Hence it is seen that the so-called spinning of prior commercial asbestos yarn is in reality merely a twisting operation.

Drafting systems as employed in the production of yarns from fibrous materials other than asbestos have not been applicable to the drafting of asbestos rovings, due to the weakness, short fiber length, lack of cohesion, and other characteristics of the asbestos fiber used. Asbestos yarns as prepared by prior commercial methods, are unbalanced, uneven, rough, loosely compacted, relatively coarse and can be made only at a relatively low speed. Furthermore, the finest gauge of such asbestos yarn which it is feasible to manufacture on a commercial scale by the prior methods is about 35-cut, the same having a maximum twist of about 17 turns per inch, and such fine yarn could only be made by the use of the #1 grade fibre, or a mixture of this and #2.

An object of the present invention is to provide a drafted and twisted asbestos yarn.

Another object is to provide asbestos yarn of more uniform size and quality, greater strength and compactness, better balance, and, for a given size, a cheaper yarn.

Another object is to provide asbestos yarn of finer gauge and a balanced yarn with higher twist than has heretofore been obtainable.

Another object is to provide asbestos yarns in the finer sizes while employing fibres of such short staple that they could not previously be used for this purpose.

For a detailed disclosure of the nature and objects of the invention, reference is had to the accompanying specification and drawings, in which latter:

Fig. 1 is a diagrammatic side elevation of a suitable form of apparatus for making the improved yarn;

Fig. 2 is a diagrammatic plan view of the drive mechanism for the various parts;

Fig. 3 is a detail on a larger scale of a modified form of drafting apparatus;

Fig. 4 is a similar detail of another modified form of drafting apparatus;

Fig. 5 is a similar detail of still another modification; and

Fig. 6 is a similar detail of a still further modification.

In making the yarn, an asbestos roving, which may be formed by the usual methods, may be led first through a wetting bath, then through a suitable drafting mechanism, and thence to a suitable twisting device, such as an ordinary ring spinning frame, by which it is twisted and wound on a bobbin.

The wetting bath serves to condense the roving and, by the mutual cohesion of the fibers, to increase its resistance to drafting, whereby the drafting takes place smoothly and uniformly.

When, as may occur, the rovings are somewhat oily as a consequence of their method of manufacture, the wetting of the fibers may be aided by the inclusion of a suitable proportion of a textile wetting agent in the aqueous bath. The use of too great a concentration of such wetting agent

is to be avoided, as this tends to cause the absorption of so much water that the roving becomes swollen rather than condensed. Suitable concentrations of wetting agent are readily determined by experiment, examples of such being given hereinafter. Various wetting agents may be employed, such as those commonly employed for many purposes in the textile industry. Commonly used forms of wetting agents are salts, such as the sodium salts, of sulphonated hydrocarbons, sulphonated higher alcohols and esters, or sulphonated fatty oils, among which are the trade products "Alkanol" and "Gardinol", which are, respectively, a salt of a sulphonated naphthalene and a salt of a sulphonated higher alcohol, such as lauryl or oleyl alcohol. As an example, in the present invention "Gardinol" may be used in a concentration of about 0.5%, or "Alkanol" in a concentration of about 0.2%.

It has also been found advantageous to add to the wetting bath, in addition to the wetting agent, a small proportion, such as 1%, of rubber latex unvulcanized or vulcanized, this amount of latex improving the spinning qualities of the roving but being indiscernible in the finished yarn. It is believed the latex acts to increase the resistance to drafting and/or make such resistance more uniform. Materials having equivalent properties may be used instead. However, excellent results may be obtained by wet drafting with water alone, or with water containing a small amount of glycerine.

Preferably the drafting operation is carried out in such manner that any distance over which the asbestos roving is mechanically unsupported during its passage through the drafting mechanism is not substantially greater than the effective mean length of the fibers composing the roving, whereby the drafting is effected smoothly and without the formation of undue thick and thin places.

The drafting mechanism may comprise two or more successive pairs of rolls rotating at progressively greater speeds, as in the drafting of other types of fibers, a suitable draft being from 2:1 to as high as 6:1 or 8:1.

The present invention, while equally applicable to a yarn drafted from the #1 or #2 grade of asbestos fibres, relates particularly to a drafted and twisted asbestos yarn made from relatively short staple asbestos fibers, such as have been previously used in making undrafted and twisted asbestos yarns in the range of sizes from 10–20 cut. Generally, the effective or virtual staple length of such asbestos fiber has been found to be approximately 0.5 inch. A special advantage of the present invention is its application for spinning such short fibers as are known commercially as the No. 3 or spinning quality grade and are divided into various classes by means of a standard and well known test which is as follows: Four superposed boxes are provided, the top one of which has a screen bottom with ½" openings, the wire of the screen being of a diameter of .105". Below this box is a second box provided with a screen bottom of four meshes to the inch, the wire of the screen being of a diameter of .063". Below this box is a third one having a screen bottom of ten meshes to the inch, the wire of which is of .047" diameter. Below this is a fourth box with an imperforate bottom. In testing a sample of asbestos fiber, one pound of the fiber is placed in the top box and the boxes are rapidly reciprocated for a period of two minutes, and the amounts of fiber remaining in each of the boxes are then weighed. The fourth box will contain the dust and fines.

Using the above test, the No. 3 or spinning quality grade of asbestos fiber is classified as follows:

Class	Oz. per lb.			
	Box 1	Box 2	Box 3	Box 4
1	8	6	1	1
2	7	7	1.5	0.5
3	4	7	4	1
4	2	9	4	1
5	2	8	4	2
6	1	9	4	2
7	0	10	4	2
8	0	8	6	2

While any of the above classes of the spinning quality fiber, or their equivalent, may be utilized in the present invention, or mixtures of them, the preferred classes are Nos. 3 to 6. Classes 1 and 2 are more expensive and the supply too limited to be relied on for the commercial production, and classes 7 and 8 contain such a large proportion of very short fiber asbestos that they are difficult to card and make into yarn without the addition of an undesired amount of cotton fiber. In the present invention, it is preferred not to use more than 25% cotton, and this may be decreased to as little as 8% or 10%, the higher the percentage of longer fibered asbestos, the less amount of cotton required.

While special constructions may be provided for drafting and properly supporting the asbestos roving, as will be later disclosed, it is preferred for commercial convenience to utilize to a partial extent at least present machinery such as that provided for the drafting of cotton rovings, and modify the same to provide the desired additional support for the roving between successive pairs of rolls, the latter being left with the same spacing as for drafting cotton.

In Fig. 1, there is shown a diagrammatic side view of one form of cotton spinning mechanism as modified for carrying out the process of the present invention. In this figure the numeral 1 designates a package of asbestos roving which is supported at one end by a suitable spindle to permit drawing off the roving with a minimum of tension. The roving 2 is led from the package over a guide 3 and under a guide 4, the latter being disposed below the surface of a wetting bath in the receptacle 5. After passing through the wetting bath, the roving is led over a guide roll 6 and then passes through the drafting mechanism. This mechanism in the form shown consists of a lower back roll 7, an upper back roll 8, a lower front roll 9, and an upper front roll 10, with a small intermediate roll 11 disposed to press lightly against the upper back roll 8 and be frictionally driven thereby. The lower rolls 7 and 9 are the conventional fluted steel rolls, the upper rolls 8 and 10 are rubber covered, and the small roll 11 is a metal roll provided with small, closely spaced circumferential grooves. The lower rolls 7 and 9 are positively driven while the upper rolls 8 and 10 are idler rolls which are pressed against the lower rolls.

By the construction shown and described, the asbestos fibers of the roving, which roving may or may not be lightly twisted, after passing the nip of the back rolls 7 and 8, are gripped firmly enough at the nip between the small roll 11 and the upper back roll 8 to enable them to be drafted by the pull of the front rolls 9 and 10,

while the cotton fibers are effectively gripped by the back rolls 7 and 8 and, because of their greater strength, are able to slip through the nip provided by the rolls 11 and 8. Thus the asbestos and the cotton components of the roving, respectively, are drafted concurrently from two different nips, each of which is located at the most advantageous distance from the front rolls for the proper drafting of the respective component upon which it is to operate, the distance over which the asbestos fibers are drafted being roughly one-half of that for the cotton fibers. The adherence of the wet roving to the auxiliary roll 11 also serves to prevent the asbestos fibers from being dragged ahead by the cotton fibers, thus aiding to prevent the formation of undue thick and thin places.

If additional main drafting rolls are employed, the small auxiliary roll 11 may also be duplicated.

After it issues from the rolls 9 and 10, the drafted roving passes through a pigtail guide 12, through the traveller 13 on ring 14, and is wound up as a twisted yarn on a bobbin 15 on the spindle 16.

In Fig. 2 there is shown one form of drive mechanism for the apparatus, said mechanism consisting of a motor 17 which through the belt 18 drives a pulley 19 on one end of a cylinder 20. Passing over this cylinder 20 are a series of drive belts 21 for the whirls 22 of the spindles 16. At the opposite end of the cylinder 20 there is mounted a gear 23 which through the intermeshing gears 24, 25 and 26 drives a gear 27 carried by the front draft roll 9 at one end. At the opposite end of the front draft roll is carried a gear 28, which through the intermeshing gears 29, 30, 31 and 32 drives a gear 33 carried at the end of the rear draft roll 7.

The gear 25 is interchangeable, and by varying the number of its teeth the speed of roll 9 can be varied, thus regulating the amount of twist being put into the yarn. The gear 30 is also interchangeable, and by varying the number of teeth on this gear, the speed of the rear draft roll 7 may be varied to thus vary the draft, or the ratio of surface speed of the front roll 9 to that of the rear roll 7.

In Fig. 3 there is shown on an enlarged scale a modified form of drafting mechanism comprising a lower back roll 34, an upper back roll 35, a lower front roll 36, and an upper front roll 37. Extending around the lower rolls 34 and 36 is an extensible rubber apron 38, and a small idler roll 39 may be disposed to cooperate with the apron at a point between the front and back rolls. This small roll 39 may be entirely of metal such as steel. In this form the lower rolls 34 and 36 are positively driven, while the upper rolls 35 and 37 are idler rolls and are covered with rubber in the conventional manner.

In the operation of this form of drafting mechanism the roving is fed between the upper back roll 35 and the apron 38, and is then carried by the apron to the nip between the upper front roll 37 and the apron, the roving being thus supported over the entire distance between the nips of the back and the front rolls. The pressure of the upper rolls against the apron and the lower rolls is sufficient to prevent the apron from slipping, whereby the pull exerted by the front rolls stretches the upper course of the apron in proportion to the ratio between the surface speeds of the front and back rolls, the apron retracting upon leaving the lower front roll. Thus the roving and the apron are drawn out to the same extent as they issue from the nip of the back rolls and there is substantially no relative motion between the upper course of the apron and the roving as the latter lies upon the apron.

The control of the fibers in this modification may be further increased if desired by the provision of the auxiliary small roll 39 which is disposed in contact with the upper face of the extensible apron at a point intermediate of the back and front rolls.

In Fig. 4 there is shown a further modification of the conventional cotton drafting mechanism. In this modification there are provided a lower back roll 40, an upper back roll 41, a lower front roll 42 and an upper front roll 43. An inextensible apron 44 of any suitable material, such as rubberized fabric, extends around the lower front roll 42 and around a small auxiliary roll 45, so that the apron 44 provides a support for the roving over a substantial portion of its path between the front and back rolls. A second inextensible apron 46 passes over the upper front roll 43 and also over a second small auxiliary roll 47 situated immediately above the first auxiliary roll 45. However, if desired, the second apron 46 may be omitted and the nip at the front of the drafting mechanism be provided directly between the top front roll 43 and the apron 44. In this form the lower rolls 40 and 42 are positively driven while the upper rolls 41 and 43 are idlers. The roll 41 may be rubber covered in the conventional manner.

The drafts possible with asbestos rovings are relatively low as compared with other textile fiber materials, and hence the invention has been illustrated with the use of only two pairs of rolls in the drafting frame, since this number is adequate, but if desired, intermediate rolls may be used.

In Fig. 5 there is shown a form of drafting mechanism which essentially consists of a number of pairs of relatively small bottom and top rolls. In the drawings there have been illustrated four pairs of rolls but this number may be varied, if desired. In this form the rolls are preferably of a diameter approximately only one-fourth that of the smallest rolls now in use in spinning cotton, and spaced quite close together. For example, the rolls may be about ¼ to ⅛ of an inch in diameter. In Fig. 5 there are shown pairs of lower and upper rolls 48 and 49, 50 and 51, 52 and 53, and 54 and 55. The lower rolls are positively driven at progressively greater speeds from back to front, while the upper rolls are idler rolls pressing against the lower rolls. All of the rolls are preferably fluted. It will be seen that in this form of the invention the roving is progressively drafted from the back pair to the front pair of rolls and at the same time the roving is never unsupported for a distance greater than the approximate effective length of the asbestos fibers.

In Fig. 6 there is shown another suitable form of drafting mechanism which is similar in some respects to that shown in Fig. 1 of patent to Casablancas #1,213,744. In Fig. 6 the numeral 56 represents a bottom driven back roll and an idler top back roll 57. The numeral 58 designates the driven bottom front roll, and 59 an idler top front roll. Between the back and front rolls there is disposed a driven bottom roll 60 around which is disposed an endless rubber apron 61

which also passes around a fixed bar 62 of somewhat flattened contour. A cooperating upper apron mechanism comprises a roll 63, an endless rubber apron 64 and a flattened fixed bar 65.

In spinning frames of the type shown in Fig. 1 of the Casablancas patent, the aprons or belts are made of thin leather, and they approach each other just closely enough to barely contact with the roving so as to support and feed it forward. Also the bars around which the aprons pass at the front are rounded, so that at the forward end of the nip between the two aprons the aprons diverge rather suddenly and widely. Also the belts or aprons are so spaced from the front rolls that the end of their nip is more than ⅝ of an inch from the nip of the front rolls.

In the construction employed in Fig. 6 of the present invention, the belts or aprons 61 and 64 are relatively thick and made of rubber and their spacing is such that the belts will firmly but resiliently grip the roving passing through them so as to frictionally hold it and cause the drafting of the asbestos fibers between the nip of the belts and the nip of the front rolls. The flattened bars 62 and 65 enable the nip of the belts to approach closer to the nip of the front rolls, and the belts do not diverge from each other so suddenly at the front end of their nip. By reason of this construction the unsupported distance over which the roving passes from the front end of the belt nip to the nip of the front rolls is of the order of 5/8th of an inch and preferably a half inch or less. By reason of the described construction, the unsupported distance through which the roving passes during its drafting is very short, and as a result the apparatus will successfully draft relatively short asbestos fibers.

In the asbestos art rovings and yarns are described in terms of the number of yards per pound, and the word "cut" is used to designate a unit of 100 yards. Therefore, this word, preceded by a number, indicates in multiples of 100 yards, the yardage per pound of a roving or a yarn. For example, a "10-cut yarn" indicates that a pound of the yarn measures approximately 1000 yards; 18-cut indicates a yarn that measures approximately 1800 yards per pound. A very large proportion of the woven asbestos products of commerce are made from 10-cut yarn. Undrafted asbestos yarns have on occasion been made as fine as 30 to 35-cut, using #1 and #2 grades of fibers, which represents substantially the limit of fineness which it is possible to achieve by present commercial asbestos practice, but such yarns are very difficult and expensive to manufacture.

As illustrating the advantages of the invention over the prior art, the following examples are given:

TABLE I

No. 1 Canadian crude

Example	Roving—Cut size (nominal)	Draft	B	A	A×B	Percent elongation at break	Gauge (inch)	Twist per inch
			Yarn—Cut size (actual)	Strength, single strand (lbs.)	Relative strength			
1	10	None	9	2.2	20	6.3	.047	6
2	18	None	18	1.4	25	4.8	.040	6
3	28	None	28	1.7	48	5.6	.023	12
4	35	None	37	1.2	44	4.3	.015	17
5	10	2	18	2.6	47	7.5	.029	13
6	10	2	22	3.3	73	6.3	.023	12
7	10	3.1	26	2.4	62	4.4	.016	14
8	10	5.3	55	1.5	83	4.2	.013	20
9	15	3.1	44	1.3	43	3.3	.016	21
10	15	5.3	76	0.66	50	1.6	.010	24
11	15	5.3	66	0 51	34	1.8	.011	45
12	17	2.1	37	1.3	48	2.7	.017	18
13	17	3.1	51	0.90	46	2.1	.014	19
14	19	3.1	62	1.1	68	2.9	.011	22
15	19	5.3	110	0.44	48	1.6	.008	32
16	19	5.3	120	0.40	48	1.3	.007	27
17	19	5.3	135	0.28	38	1.1	.007	32
18	19 (2 ends)	5.3	46	1.5	69	5.1	.014	20
19	19 (2 ends)	3.1	31	2.2	68	4.4	.019	12

*No. 1 Canadian crude is a commercial asbestos fiber averaging ¾" staple length.

TABLE II

No. 3 grade spinning quality fiber (Class 5)

Example	Roving—Cut size (nominal)	Draft	B	A	A×B	Percent elongation at break	Gauge (inch)	Twist per inch
			Yarn—Cut size (actual)	Strength, single strand (lbs.)	Relative strength			
20	10	None	9	2.0	18	8.4	.039	6
21	10	2	20	1.2	24	4.2	.021	11
22	10	3.1	35	0.80	28	2.0	.020	14
23	10	5.3	55	0.53	29	1.8	.014	21
24	10 (2 ends)	4	18	1.5	27	7.7	.022	12

In the above tables the yarn of Example 5 was made with a concentration of 0.5% "Gardinol" in water as a wetting agent, the yarn of Example 10 was made with the use of 0.5% "Alkanol", and the yarns of Examples 6 to 9 and 11 to 24 inclusive were made with the use of 0.2% "Alkanol". Also in Examples 8, 15 to 19 and 23 there was included 1% of a 25% concentration latex in the wetting bath. In the above tables Examples 1 to 4 and 20 are blanks and are given to show the characteristics of undrafted and unwetted asbestos yarns made by prior art methods. Obviously in an asbestos yarn made from an undrafted roving the size-cut should be the same for the finished yarn as for the roving, and it will be noted in the above tables that this is not strictly correct for Examples 1, 4, and 20. The discrepancy is caused by the fact that the nominal cut-sizes of the rovings used in these examples are the sizes as designated by the manufacturer of the roving, while the cut-sizes of the yarns produced were determined by actual weighing of measured lengths of yarn. The actual size of a roving may vary from the nominal size by as much as 10% or more in either direction.

The figures given in the column headed "Relative strength" give the strength in terms of a hypothetical 1-cut yarn, and accordingly afford a comparison of the strength of yarns of different sizes on an equal weight-per-unit-length basis.

In the textile art the twist to be imparted to a yarn is ascertained by multiplying the square root of the yarn size by a predetermined number termed the "twist multiplier", or stated in another way, the twist multiplier is equal to the number of twists per inch divided by the square root of the yarn size.

As previously stated, the finest asbestos yarns which it has been practicable to manufacture on a commercial scale by prior methods using no drafting is about 35-cut, with a maximum twist of about 17 turns per inch. In prior art Example 4 of Table I, it will be noted that a roving of a nominal cut size of 35 had an actual cut size in the finished undrafted yarn of 37, and the twist per inch was 17, giving in this case a twist multiplier of 2.8. Due to the relative stiffness of the asbestos fibers in commercial asbestos rovings, most of the asbestos yarn produced heretofore has been made with a twist multiplier of 2 or less, in order to obtain a yarn more or less balanced which does not kink, and it has been impractical in any case to use a twist multiplier higher than about 2¾. However, it will be noted that by the present invention the wetting out of the fibers makes them softer and more pliable whereby a substantially higher twist multiplier can be employed without seriously affecting the balance or kink condition, and that the finished yarn is denser and for the same cut size is smaller in gauge than the undrafted yarns of the prior art. For instance, in Example 5 the twist per inch was 13 and the cut size of the yarn was 18, which gives a twist multiplier of 3; in Example 9 the twist per inch was 21 and the cut size of the yarn was 44, which gives a twist multiplier of 3.2; in Example 11 the twist per inch was 45 and the cut size of the yarn was 66, which gives a twist multiplier of 5.5; in Example 12 the twist per inch was 18 and the cut size 37, which gives a twist multiplier of 3; in Example 15 the twist per inch was 32 and the cut size 110, which gives a twist multiplier of 3; and in Example 18 the twist per inch was 20 and the cut size 46, which gives a twist multiplier of 3.

In order to furnish a still plainer basis for comparison of the advantages of the present invention over the prior art a series of yarns were made from the same batch of 10-cut roving of No. 1 Canadian asbestos fiber, the analysis of which yarns is shown in the following table:

TABLE III

Example	Roving—Cut size (nominal)	Draft	B	A	A×B	Percent elongation at break	Gauge (inch)	Twist per inch
			Yarn—Cut size (actual)	Strength, single strand (lbs.)	Relative strength			
A	10	3.1	26	2.4	62	4.8	.022	12
B*	10	3.1	24	1.4	34	3.9	.027	12
C	10	None	10	2.3	23	3.3	.029	5
D*	10	None	8	2.1	17	6.1	.056	6
E	10 2 ends	2.1	8	8.1	65	3.0	.030	6
F	10 3 ends	3.1	9	4.5	41	2.2	.031	6

* In Examples B and D no wetting was used.

In Examples A, C, E and F the fibers were wet by using a 0.2% concentration of "Alkanol" in water plus 1% of a 25% concentration latex.

Comparing Examples D, C, B and A, it will be seen that in prior art Example D, using neither drafting nor wetting, the relative strength or strength factor was 17, in C using wetting but no draft the relative strength was 23, in B using draft but no wetting the relative strength was 34, while in A using both draft and wetting the relative strength was 62.

In Examples B and A there is clear evidence of the advantage of using wetting for the drafting. In both examples the draft and twist were identical, and the yarn cut-sizes were very close, considering that the same uniformity cannot be obtained with asbestos fibers as with ordinary textile fibers such as cotton. However, it will be noted that the relative strength of the dry-drafted yarn B was 34, while that of wet-drafted yarn A was 62. It will also be noted that the gauge of yarn B was .027, while that of yarn A was .022, indicating that in the wetted yarn the fibers had been drawn more in parallel and were better compacted.

In Examples D, E and F the purpose was to compare an undrafted prior art yarn with drafted yarns, using the same twist and as nearly as possible the same cut-size of finished yarn. It will be noted that in prior art undrafted and unwetted Example D the relative strength was 17, while for drafted and wetted Examples E and F it was 65 and 41, respectively. These same examples further indicate the value of the drafting and

wetting in increasing compactness, since in the undrafted Example D the gauge was .056, while in drafted and wetted Examples E and F the gauges were .030 and .031, respectively.

A desirable feature of the invention is the drafting and twisting of two or more rovings to form a single yarn as illustrated in Examples 18 and 19 of Table I, Example 24 of Table II, and Examples E and F of Table III. By drafting two or more rovings and increasing the amount of draft a multiple roving yarn can be obtained of the same size-cut as that obtained from a single roving with a less amount of draft, and at the same time the roving is much more uniform and the breaks or ends down are decreased. For instance, two rovings of 20-cut size may be given a draft of four to produce a finished yarn of approximately 40-cut size, instead of employing a single roving of 20-cut size and giving it a draft of two to produce a finished yarn of approximately 40-cut size. The yarn made from the multiple roving with increased draft will, as before stated, be more uniform, and the number of ends down be considerably reduced.

It will be seen that by the invention the manufacture of asbestos yarns of various sizes is greatly simplified, and also cheapened, inasmuch as a wide range of sizes of yarn may be produced from a single size of roving, merely by varying the speeds of the draft rolls. For example, from a 10-cut roving there may be made any smaller size of yarn down at least to 55-cut, the latter being materially finer than any heretofore produced. Similarly, by the use of a smaller roving, such as 19-cut, there may be made asbestos yarns of extremely fine gauge, such as 60-cut to 135-cut, which yarns are comparable in size with ordinary sewing threads and greatly extend the field of use of asbestos yarns. The yarns produced by the invention are well balanced and may be given a much higher twist, especially in finer sizes.

It has also been found that higher spindle speeds may be used without increasing the frequency of breakage, and that a greater yardage of yarn of a given cut-size may be wound on a single bobbin.

The yarns made by the present process are also smaller and more compact than yarns of the same cut-size made by present commercial methods, and are at least 50% stronger, for yarns of the same cut-size. Furthermore, by the invention low quality asbestos fiber, previously used only for the production of coarse yarns, may be made into fine yarns of relatively greater strength. Yarns of greater uniformity may be made according to the invention by drafting and twisting together a plurality of asbestos rovings to form a single yarn.

Since in the asbestos art the term "asbestos" is applied not only to products containing asbestos solely but also to products containing a minor amount of vegetable or other fiber, in the claims it is intended that the expressions "asbestos roving" and "asbestos yarn", unless specifically limited, shall include asbestos rovings and yarns in which small amounts of other fibers may be included.

While specific embodiments on the invention have been shown and described, it is obvious that modifications may be made therein without departing from the spirit thereof, and it is not desired to limit the invention otherwise than as set forth in the appended claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A yarn comprising at least 75% of drafted and twisted asbestos fibers, the average staple length of said fibers not exceeding three quarters of an inch.

2. A yarn comprising at least 75% of drafted and twisted asbestos fibers and a minor amount of cotton fibers, the average staple length of said asbestos fibers not exceeding three quarters of an inch.

3. A yarn comprising at least 75% of wet-drafted and twisted asbestos fibers, the average staple length of said asbestos fibers not exceeding three-quarters of an inch.

4. A yarn comprising wet-drafted and twisted asbestos and organic fibers, the asbestos being at least 75% of the whole, and the average staple length of said asbestos fibers not exceeding three-quarters of an inch.

5. A yarn comprising at least 75% of wet-drafted and twisted asbestos fibers, said yarn having at least 50% greater breaking strength than that of an undrafted twisted asbestos yarn of like size-cut, quality and construction, and the average staple length of said asbestos fibers not exceeding three-quarters of an inch.

6. A yarn including at least 75% of wet-drafted and twisted asbestos fibers and a small amount of cotton fibers, the average staple length of said asbestos fibers not exceeding three-quarters of an inch.

7. A drafted and twisted yarn comprising at least 75% of drafted and twisted asbestos fibers, said asbestos fibers being of a length such that up to approximately eight ounces per pound thereof will be retained on a screen of one-half inch opening, and ten to six ounces on a screen of four meshes to the inch.

8. A drafted and twisted yarn comprising at least 75% of drafted and twisted asbestos fibers, said asbestos fibers being of a length such that approximately from one to four ounces per pound thereof will be retained on a screen of one-half inch opening, and nine to seven ounces on a screen of four meshes to the inch.

9. A drafted and twisted yarn comprising at least 75% of drafted and twisted asbestos fibers, said asbestos fibers being of a length such that approximately from eight to fourteen ounces per pound thereof will be retained on a screen of four meshes to the inch.

10. A drafted and twisted yarn comprising at least 75% of drafted and twisted asbestos fibers, said asbestos fibers being of varying short lengths such that approximately from ten to eleven ounces per pound thereof will be retained on a screen of four meshes to the inch.

11. A drafted and twisted yarn comprising at least 75% of drafted and twisted asbestos fibers, said asbestos fibers being of a length such that approximately up to eight ounces per pound thereof will be retained on a screen of one-half inch opening, ten to six ounces on a screen of four meshes to the inch, and six to one ounces on a screen of ten meshes to the inch.

12. A yarn comprising drafted and twisted asbestos and organic fibers, the asbestos being at least 75% of the whole, said asbestos fibers being comparatively short and in major part capable of passing a screen of one-half inch opening.

13. A drafted asbestos yarn having a length of over 3,000 yards per pound, comprising at least 75% of asbestos fibers, the drafted asbestos fibers being comparatively short and in major part capable of passing a screen of one-half inch opening.

14. A drafted asbestos yarn having a length

of over 5,000 yards per pound, comprising at least 75% of drafted asbestos fibers and a small amount of cotton fibers, the asbestos fibers being comparatively short and in major part capable of passing a screen of one-half inch opening.

15. A drafted asbestos yarn having a length of over 7,500 yards per pound, the drafted asbestos fibers thereof being comparatively short and of a length such that at least fourteen to fifteen and one-half ounces per pound will be retained on successive screens of one-half inch opening, four meshes to the inch and ten meshes to the inch.

16. A drafted asbestos yarn comprising cotton and asbestos fibers, the drafted asbestos fibers thereof being at least 85% of the whole, and said asbestos fibers being comparatively short and in major part capable of passing a screen of one-half inch opening.

17. An asbestos yarn formed of a plurality of drafted-together and twisted rovings, the asbestos fibres of which have an average staple length not exceeding three-quarters of an inch.

18. An asbestos yarn formed of a plurality of drafted-together and twisted rovings, the asbestos fibres of which are capable in major part of passing a screen of one-half inch opening, said yarn being of a numerically greater size-cut than that of the original individual rovings.

BOUTWELL H. FOSTER.